Honor Code of the School of Engineering

“All students taking courses in the School of Engineering agree, individually and collectively, that they will not give or receive unpermitted aid in examinations or other course work that is to be used by the instructor as the basis of grading.”

-From the Graduate/Undergraduate Bulletin

I have read, understood, and agree to abide by the Honor Code of the School of Engineering.

Name: ____________________________

ID: ______________________________

Signature: _________________________

Date: _____________________________

1. [20 points] When the hash table becomes more than half full in close hashing, a new table twice as large is constructed, and the entire old table is rehashed. The big-Oh for rehashing is $O(n)$. Please give amortized big-Oh for hash insertion.

2. [20 points] Given an adjacency-list representation of a directed graph, how long does it take to compute the out-degree of every vertex? How long does it take to compute the indegree? If using adjacency-matrix, how long does it take to compute the out-degree of every vertex?

3. [20 points] Given a directed unweighted graph $G = (V, E)$ with it adjacency matrix representation, determine whether there is a path of length one or more from vertex $i$ to vertex $j$. Please write an efficient algorithm which computes a matrix $A$ such that $A[i,j] = 1$ if there is a path of length one or more from $i$ to $j$, and 0 otherwise.
   a) please write the pseudocodes to solve this problem, and
   b) show the run time of your algorithm.

4. [20 points] Please write a nondeterministic algorithm to solve the CNF satisfiability problem, and give the big-Oh of your algorithm.

5. [20 points] Please indicate whether the problem is P or NP for the listed problems below: 1-SAT, 2-SAT, 3-SAT, planar graph 2-colorability, planar graph 3-colorability, planar graph 4-colorability, shortest path between two cities, longest path between two cities, 2-partition, and 3-partition. If you answer correctly for a problem, you get 2 points, but if you answer wrongly for a problem, you get −2 points.

6. [20 points] Please draw the Euler path or cycle for a complete graph with 5 nodes.

7. [20 points] Please write the pseudo code for all possible topological sorting sequences for a given DAC.
8. [20 points] Please provide all transitions to show how a Turing machine computes $i++$ given input $i$.

9. [20 points] Please prove the 3-SAT problem is NP-complete.

10. [20 points] Please find shortest path of the following graph (with added super source S for easy to do Fellman-Ford reweighting algorithm).

   **Add super source**